

What is claimed is:

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- 1 1. A computer-implemented method of measuring a frequency of execution of a
2 hierarchical software path, the method comprising:
3 when entering an inner region, saving an outer path sum;
4 initializing an inner path sum;
5 summing edge values encountered in the inner region with the inner path
6 sum; and
7 when exiting the inner region, modifying a profile indicator that represents
8 the frequency of execution of a path within the inner region, and restoring the outer
9 path sum.

- 1 2. The computer-implemented method of claim 1 wherein initializing an inner
2 path sum comprises initializing the inner path sum to a value corresponding to an
3 edge from a region source node to an entry node of the inner region.

- 1 3. The computer-implemented method of claim 2 wherein modifying a profile
2 indicator comprises indexing into an array of profile indicators using the inner path
3 sum.

- 1 4. The computer-implemented method of claim 3 wherein the array of profile
2 indicators is dedicated to paths in the inner region.

- 1 5. The computer-implemented method of claim 1 wherein initializing an inner
2 path sum comprises initializing the inner path sum to a value corresponding to an
3 edge from a function entry to an entry node of the inner region.

- 1 6. The computer-implemented method of claim 5 wherein modifying a profile
2 indicator comprises indexing into an array of profile indicators using the inner path
3 sum.

1 7. The computer-implemented method of claim 6 wherein the array of profile
2 indicators includes profile indicators corresponding to paths in the inner region and
3 profile indicators corresponding to paths outside the inner region.

1 8. The computer-implemented method of claim 1 wherein the profile indicator
2 includes a profile counter, and modifying the profile indicator comprises generating a
3 counter address as a function of the inner path sum.

1 9. The computer-implemented method of claim 1 wherein the inner region
2 includes a plurality of paths, each having an inner path sum corresponding thereto,
3 the inner path sums corresponding to the plurality of paths in the inner region being
4 unique relative to each other.

1 10. The computer-implemented method of claim 9 wherein the inner region is
2 one of a plurality of inner regions, and the inner path sums of the inner region are
3 unique relative to inner path sums corresponding to other inner regions.

1 11. The computer-implemented method of claim 1 wherein saving an outer path
2 sum comprises pushing the outer path sum onto a stack.

1 12. The computer-implemented method of claim 11 wherein restoring the outer
2 path sum comprises popping the outer path sum from the stack.

1 13. ~~A computer-implemented method of augmenting a control flow graph in~~
2 ~~support of hierarchical path profiling, the control flow graph having an outer region~~
3 ~~and an inner region, the method comprising:~~
4 ~~identifying a representative entry node for the inner region;~~
5 ~~replacing the inner region with the representative entry node;~~

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7 for each prolog node of the inner region, adding an edge from the prolog node
8 to the representative entry node; and
9 for each epilog node of the inner region, adding an edge from the
representative entry node to the epilog node.

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1 14. The computer-implemented method of claim 13 further comprising:
2 assigning edge values to all edges in the control flow graph such that the sum
3 of the edge values along each unique path is unique within the control flow graph.

1 15. The computer-implemented method of claim 13 further comprising:
2 creating a region source node for the outer region;
3 for each entry node of the outer region, adding an edge from the region
4 source node to the entry node;
5 creating a region sink node for the outer region; and
6 for each exit node of the outer region, adding an edge from the exit node to
7 the region sink node.

1 16. The computer-implemented method of claim 15 wherein the control flow
2 graph includes a plurality of inner regions, and the actions of the method are applied
3 for each of the plurality of inner regions, such that a different augmented control
4 flow graph is created for each of the plurality of inner regions.

1 17. The computer-implemented method of claim 15 wherein the control flow
2 graph includes a hierarchy of inner regions, and the actions of the method are applied
3 recursively to the hierarchy of inner regions, such that a different augmented control
4 flow graph is created for each inner region in the hierarchy of inner regions.

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1 18. A computer-implemented method of augmenting a control flow graph in
2 support of profiling a hierarchical path within a software function, the method
3 comprising:

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Identifying a representative path within an inner region of the software
 5 function, the representative path being identified by a representative entry node and a
 6 representative exit node;
 7 for each prolog node of the inner region, adding an edge from the prolog node
 8 to the representative entry node; and
 9 for each epilog node of the inner region, adding an edge from the
 10 representative exit node to the epilog node.

19. The computer-implemented method of claim 18 further comprising:
 2 removing any edges from prolog nodes of the inner region to entry nodes of
 3 the inner region other than the representative entry node; and
 4 removing any edges from exit nodes of the inner region other than the
 5 representative exit node to epilog nodes of the inner region.

20. The computer-implemented method of claim 18 wherein the software
 2 function has a function entry and a function exit, and the inner region has at least one
 3 entry node and at least one exit node, the method further comprising:
 4 adding an edge from the function entry to each of the at least one entry node
 5 of the inner region; and
 6 adding an edge from each of the at least one exit node of the inner region to
 7 the function exit.

21. The computer-implemented method of claim 20 wherein the control flow
 2 graph includes a plurality of inner regions, and the actions of the method are applied
 3 for each of the plurality of inner regions.

22. The computer-implemented method of claim 20 wherein the control flow
 2 graph includes a hierarchy of inner regions, and the actions of the method are applied
 3 recursively to the hierarchy of inner regions.

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1 23. The computer-implemented method of claim 20 further comprising:
2 assigning edge values to all edges in the control flow graph such that the sum
3 of the edge values along each unique path is unique within the control flow graph.

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1 24. A machine readable medium including instructions for a method of
2 augmenting a control flow graph in support of profiling a hierarchical path within a
3 software function, the method comprising:
4 identifying a representative path within an inner region, the representative
5 path being identified by a representative entry node and a representative exit node;
6 for each prolog node of the inner region, adding an edge from the prolog node
7 to the representative entry node; and
8 for each epilog node of the inner region, adding an edge from the
9 representative exit node to the epilog node.

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1 25. The machine readable medium of claim 24 wherein the software function has
2 a function entry and a function exit, and the inner region has at least one entry node
3 and at least one exit node, the method further comprising:
4 adding an edge from the function entry to each of the at least one entry node
5 of the inner region; and
6 adding an edge from each of the at least one exit node of the inner region to
7 the function exit.

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1 26. A computer-implemented method for instrumenting software in support of
2 hierarchical path profiling comprising:
3 at an entry to an inner region, inserting an instruction to save an outer path
4 sum;
5 within the inner region, inserting instructions to sum edge values into an
6 inner path sum; and
7 at an exit from the inner region, inserting an instruction to increment a
8 counter addressed as a function of the inner path sum.

1 27. ~~The computer-implemented method of claim 26 further comprising:~~
2 ~~at the exit from the inner region, inserting an instruction to restore the outer~~
3 ~~path sum.~~

1 28. ~~The computer-implemented method of claim 27 wherein the inner region is~~
2 ~~one of a plurality of inner regions in a hierarchical arrangement, and the actions of~~
3 ~~the method are applied to each of the plurality of inner regions.~~

29. A machine readable medium including instructions for a method of instrumenting software in support of hierarchical path profiling, the method comprising:

- at an entry to an inner region, adding an instruction to save an outer path sum;
- within the inner region, adding instructions to sum edge values into an inner path sum; and
- at an exit from the inner region, adding an instruction to increment a counter addressed as a function of the inner path sum.

1 30. The machine readable medium of claim 29, the method further comprising:
2 at the exit from the inner region, inserting an instruction to restore the outer
3 path sum.

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